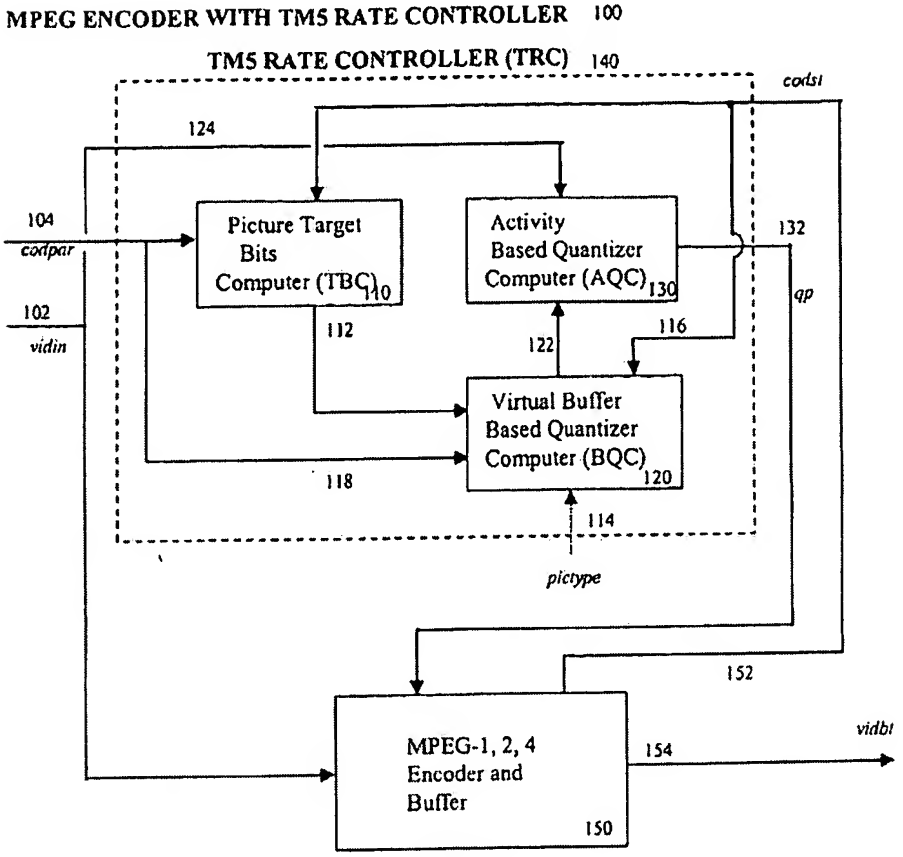

FIG. 1

(PRIOR ART)

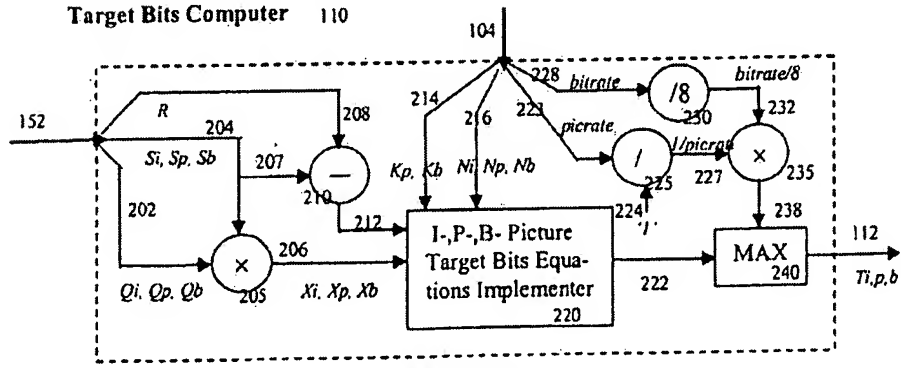

FIG. 2A

(PRIOR ART)

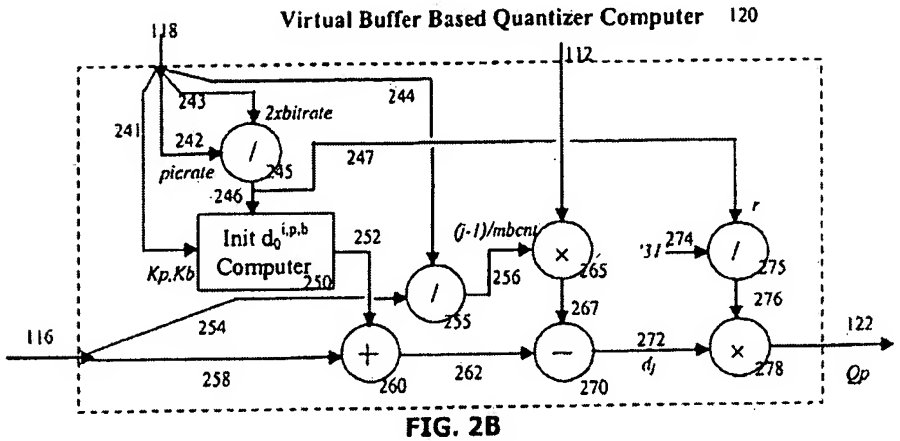

FIG. 2B

(PRIOR ART)

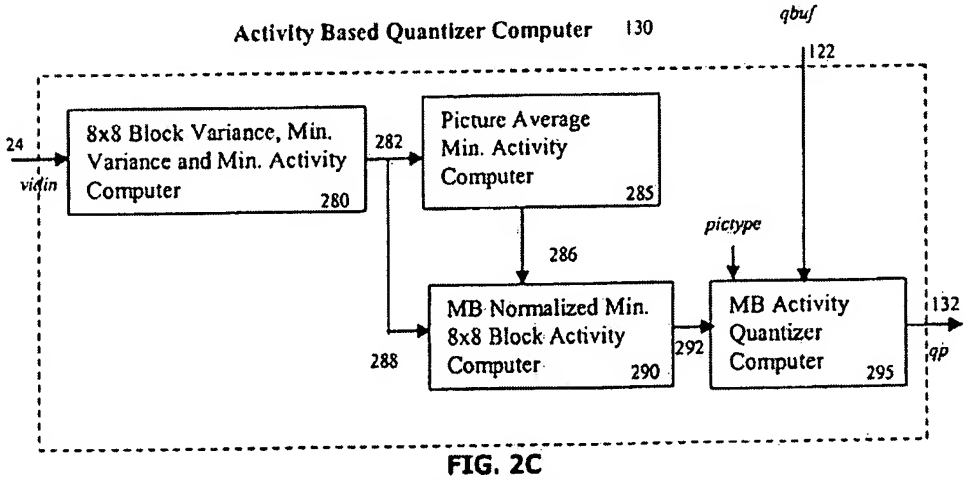

FIG. 2C

(PRIOR ART)

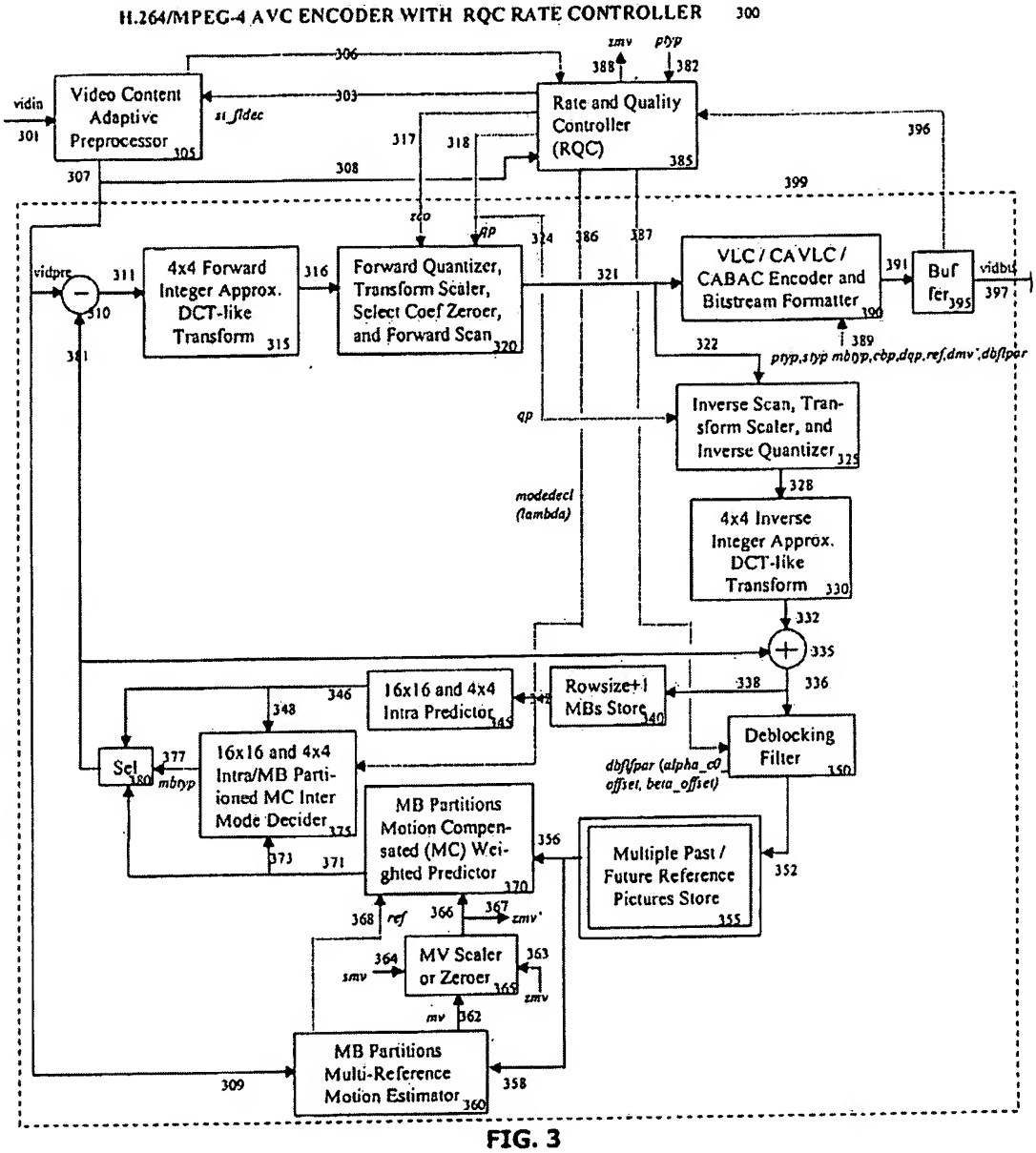
H.264/MPEG-4 AVC ENCODER WITH RQC RATE CONTROLLER 300
vidin
301
Video Content Adaptive Preprocessor 305
si_fldec
Rate and Quality Controller (RQC) 385
zmv
pdyp
388
382
306
303
317
318
308
307
396
399
zco
qp
324
386
387
vidpre
311
310
4x4 Forward Integer Approx. DCT-like Transform 315
316
Forward Quantizer, Transform Scaler, Select Coef Zeroer, and Forward Scan 320
321
VLC / CAVLC / CABAC Encoder and Bitstream Formatter 390
391
Buffer 395
vidbts
397
322
389
ptyp,styp mbyp,cbp,dqp,ref,dmv',dbflpar
Inverse Scan, Transform Scaler, and Inverse Quantizer 325
qp
328
4x4 Inverse Integer Approx. DCT-like Transform 330
modedecl (lambda)
332
335
336
338
16x16 and 4x4 Intra Predictor 345
346
348
Rowsize+1 MBs Store 340
Deblocking Filter 350
dbflfpar (alpha_c0_offset, beta_offset)
Sel 380
377
mbyp
16x16 and 4x4 Intra/MB Partitioned MC Inter Mode Decider 375
373
371
MB Partitions Motion Compensated (MC) Weighted Predictor 370
356
Multiple Past / Future Reference Pictures Store 355
352
368
ref
366
367
zmv'
364
smv
MV Scaler or Zeroer 365
363
zmv
mv
362
MB Partitions Multi-Reference Motion Estimator 360
309
358

FIG. 3

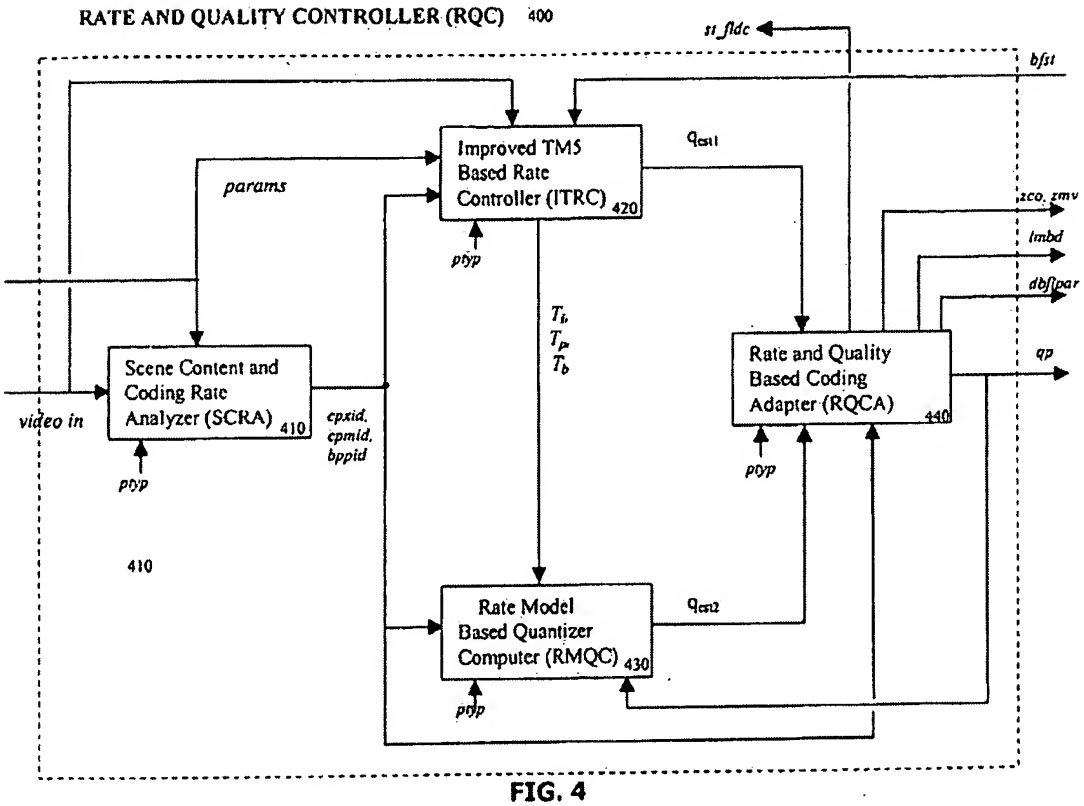
RATE AND QUALITY CONTROLLER (RQC) 400
st_fldc
bfst
Improved TM5 Based Rate Controller (ITRC) 420
params
ptyp
q_{cst1}
T_i
T_p
T_b
zco, zmv
lmbd
dbflpar
qp
Scene Content and Coding Rate Analyzer (SCRA) 410
video in
cpxid, cpmid, bppid
Rate and Quality Based Coding Adapter (RQCA) 440
Rate Model Based Quantizer Computer (RMQC) 430
q_{cst2}
410

FIG. 4

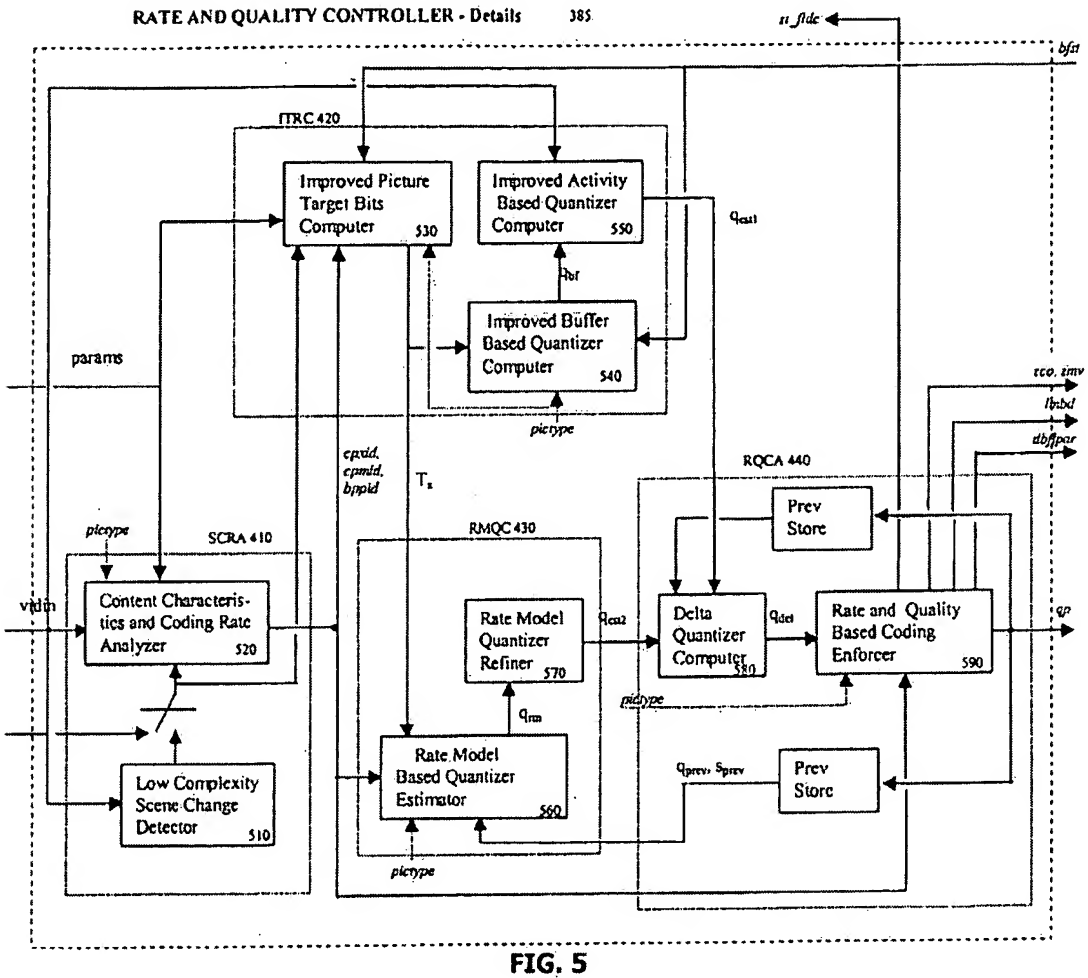
RATE AND QUALITY CONTROLLER - Details 385
ri_flde
bfst
ITRC 420
Improved Picture Target Bits Computer 530
Improved Activity Based Quantizer Computer 550
q_{cal1}
ρ_{bf}
Improved Buffer Based Quantizer Computer 540
params
pictype
eco, imv
lbtbd
dbflpar
epvid, epmid, bppid
T_R
RQCA 440
Prev Store
picype
SCRA 410
RMQC 430
vidin
Content Characteristics and Coding Rate Analyzer 520
Rate Model Quantizer Refiner 570
q_{cal2}
Delta Quantizer Computer 580
q_{del}
Rate and Quality Based Coding Enforcer 590
qp
pictype
q_{rm}
Low Complexity Scene Change Detector 510
Rate Model Based Quantizer Estimator 560
q_{prev}, s_{prev}
Prev Store
pictype

FIG. 5

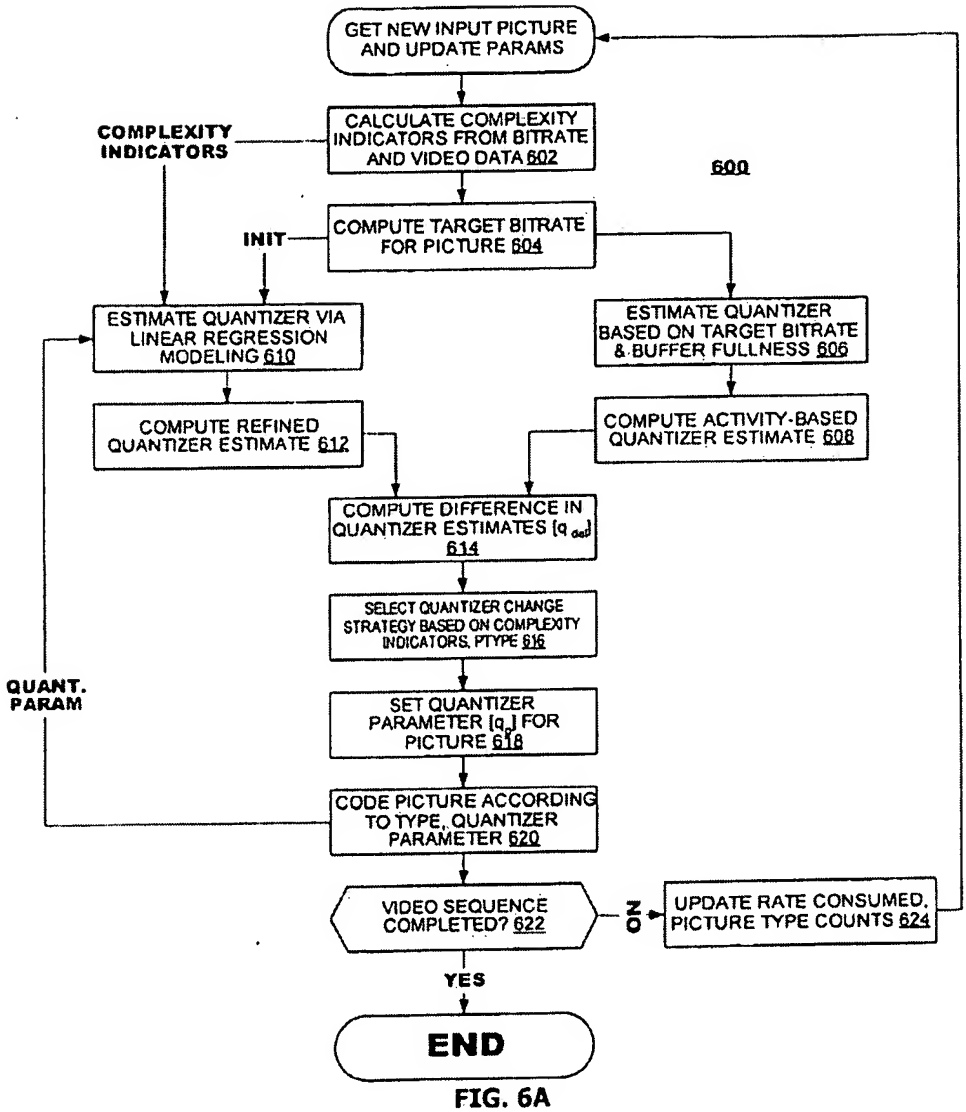
GET NEW INPUT PICTURE AND UPDATE PARAMS
COMPLEXITY INDICATORS
CALCULATE COMPLEXITY INDICATORS FROM BITRATE AND VIDEO DATA 602
600
INIT
COMPUTE TARGET BITRATE FOR PICTURE 604
ESTIMATE QUANTIZER VIA LINEAR REGRESSION MODELING 610
ESTIMATE QUANTIZER BASED ON TARGET BITRATE & BUFFER FULLNESS 606
COMPUTE REFINED QUANTIZER ESTIMATE 612
COMPUTE ACTIVITY-BASED QUANTIZER ESTIMATE 608
COMPUTE DIFFERENCE IN QUANTIZER ESTIMATES [q_{del}] 614
SELECT QUANTIZER CHANGE STRATEGY BASED ON COMPLEXITY INDICATORS, PTYPE 616
QUANT. PARAM
SET QUANTIZER PARAMETER [q_p] FOR PICTURE 618
CODE PICTURE ACCORDING TO TYPE, QUANTIZER PARAMETER 620
VIDEO SEQUENCE COMPLETED? 622
NO
UPDATE RATE CONSUMED, PICTURE TYPE COUNTS 624
YES
END

FIG. 6A

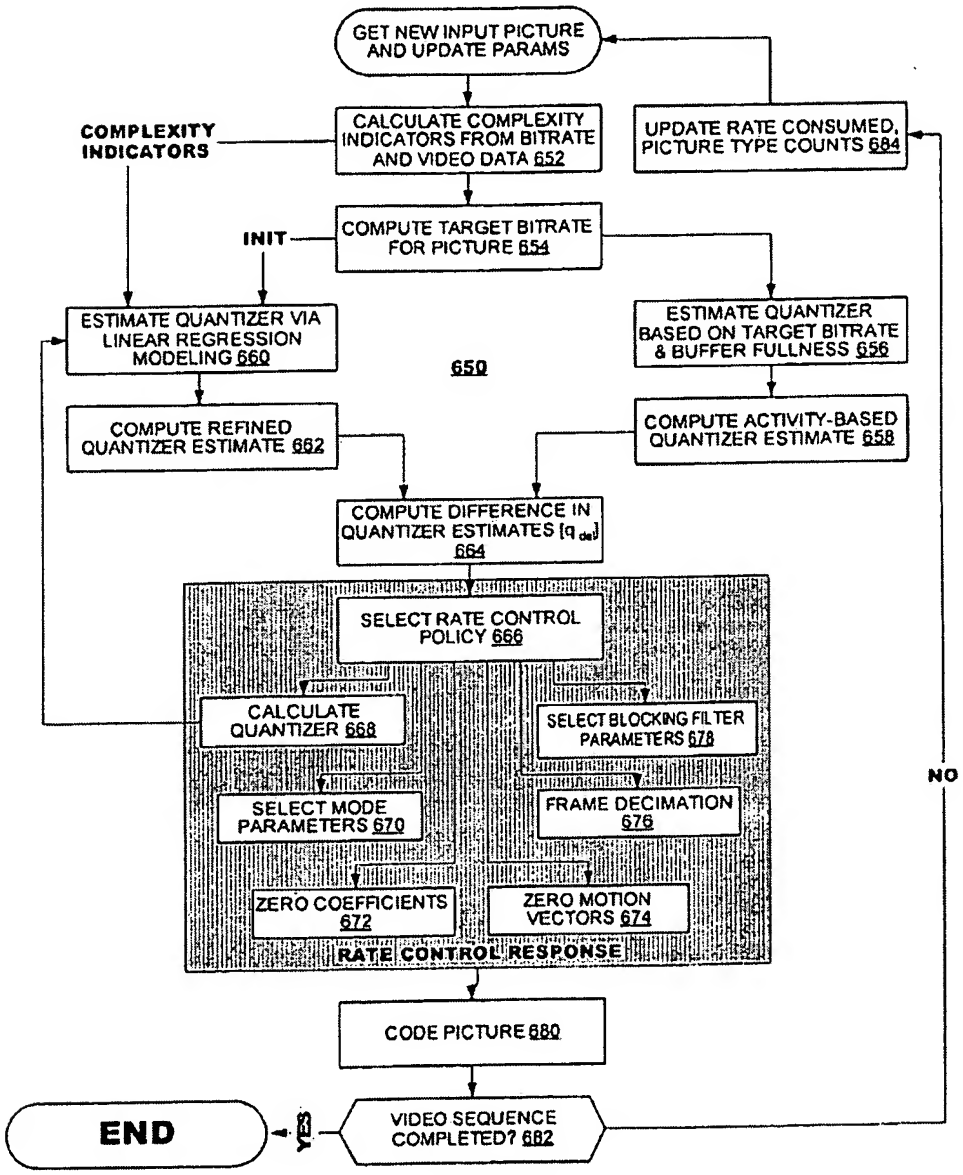
GET NEW INPUT PICTURE AND UPDATE PARAMS
CALCULATE COMPLEXITY INDICATORS FROM BITRATE AND VIDEO DATA 652
COMPLEXITY INDICATORS
UPDATE RATE CONSUMED, PICTURE TYPE COUNTS 684
COMPUTE TARGET BITRATE FOR PICTURE 654
INIT
ESTIMATE QUANTIZER VIA LINEAR REGRESSION MODELING 660
ESTIMATE QUANTIZER BASED ON TARGET BITRATE & BUFFER FULLNESS 656
650
COMPUTE REFINED QUANTIZER ESTIMATE 662
COMPUTE ACTIVITY-BASED QUANTIZER ESTIMATE 658
COMPUTE DIFFERENCE IN QUANTIZER ESTIMATES [q del] 664
SELECT RATE CONTROL POLICY 666
CALCULATE QUANTIZER 668
SELECT BLOCKING FILTER PARAMETERS 678
SELECT MODE PARAMETERS 670
FRAME DECIMATION 676
ZERO COEFFICIENTS 672
ZERO MOTION VECTORS 674
RATE CONTROL RESPONSE
CODE PICTURE 680
NO
END
YES
VIDEO SEQUENCE COMPLETED? 682

FIG. 6B

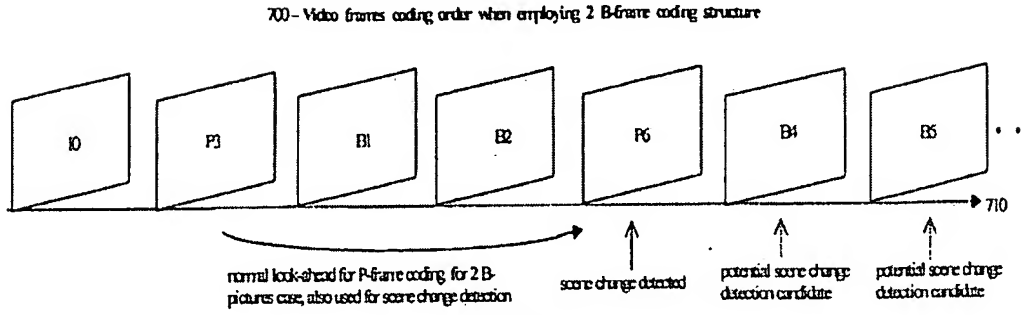
700 - Video frames coding order when employing 2 B-frame coding structure
I0
P3
B1
B2
P6
B4
B5
710
normal look-ahead for P-frame coding for 2 B-pictures case, also used for scene change detection
scene change detected
potential scene change detection candidate
potential scene change detection candidate

FIG. 7

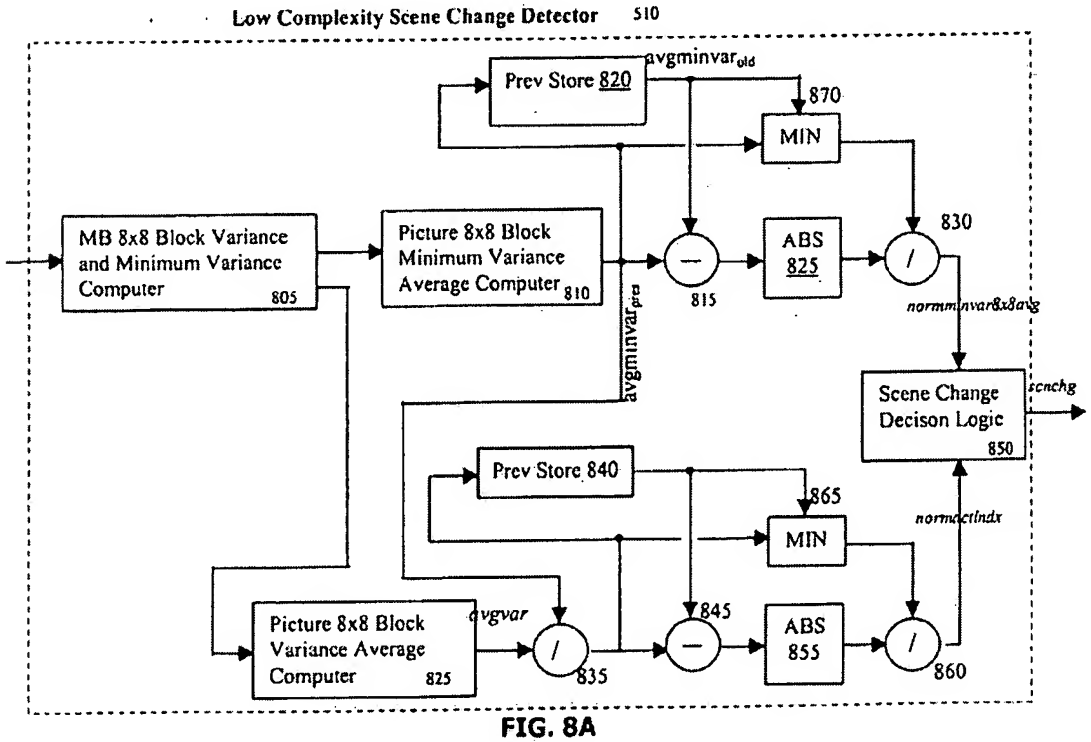
Low Complexity Scene Change Detector 510
Prev Store 820
avgminvar_old
870
MIN
MB 8x8 Block Variance and Minimum Variance Computer 805
Picture 8x8 Block Minimum Variance Average Computer 810
avgminvar_pic
815
ABS 825
830
normminvar8x8avg
Scene Change Decison Logic 850
scnchg
Prev Store 840
865
MIN
normactindx
Picture 8x8 Block Variance Average Computer 825
avgvar
835
845
ABS 855
860

FIG. 8A

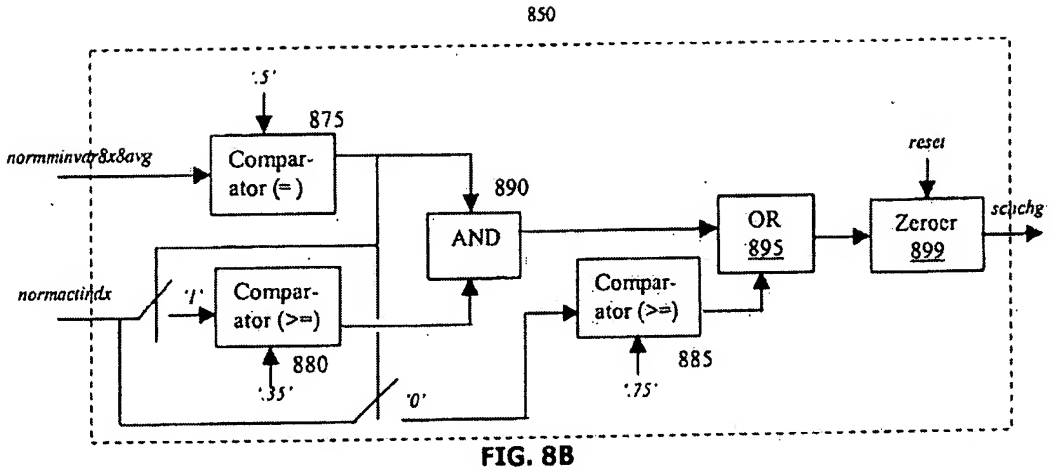
850
'.5'
875
normminvar8x8avg
Compar-
ator (=)
890
AND
OR
895
reset
Zerocr
899
schchg
normactindx
'1'
Compar-
ator (>=)
880
'.35'
'0'
Compar-
ator (>=)
885
'.75'

FIG. 8B

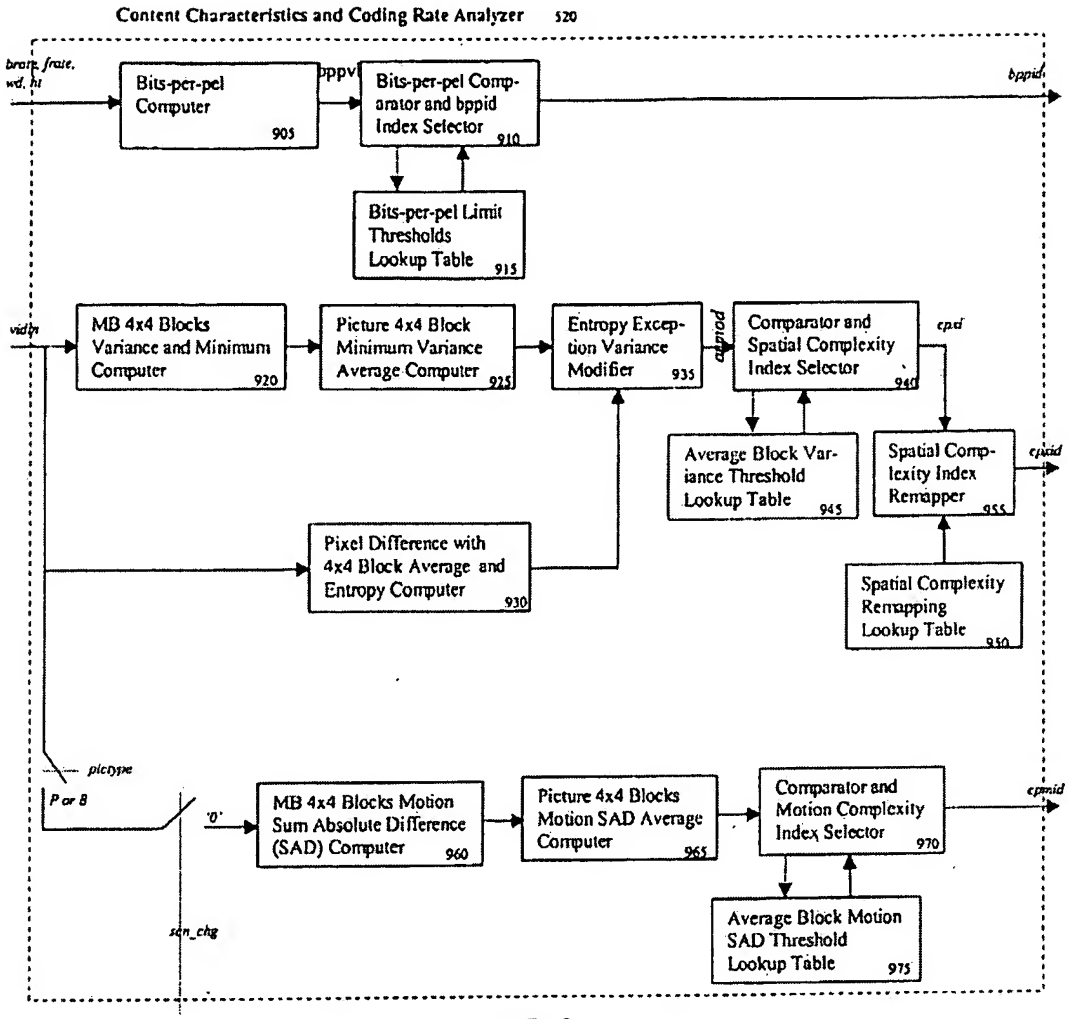
Content Characteristics and Coding Rate Analyzer 520
brate, frate, wd, ht
Bits-per-pel Computer 905
bppv
Bits-per-pel Comparator and bppid Index Selector 910
bppid
Bits-per-pel Limit Thresholds Lookup Table 915
vidin
MB 4x4 Blocks Variance and Minimum Computer 920
Picture 4x4 Block Minimum Variance Average Computer 925
Entropy Exception Variance Modifier 935
cmod
Comparator and Spatial Complexity Index Selector 940
cpxi
Average Block Variance Threshold Lookup Table 945
Spatial Complexity Index Remapper 955
cpxid
Pixel Difference with 4x4 Block Average and Entropy Computer 930
Spatial Complexity Remapping Lookup Table 950
pictype
P or B
'0'
MB 4x4 Blocks Motion Sum Absolute Difference (SAD) Computer 960
Picture 4x4 Blocks Motion SAD Average Computer 965
Comparator and Motion Complexity Index Selector 970
cpmid
Average Block Motion SAD Threshold Lookup Table 975
scn_chg

FIG. 9

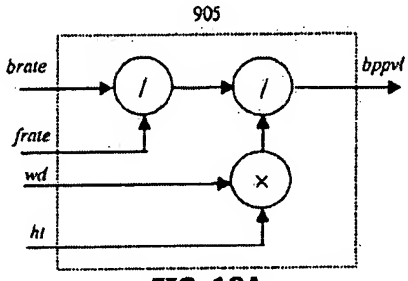
905
brate
frate
wd
ht
/
/
×
bppvl

FIG. 10A

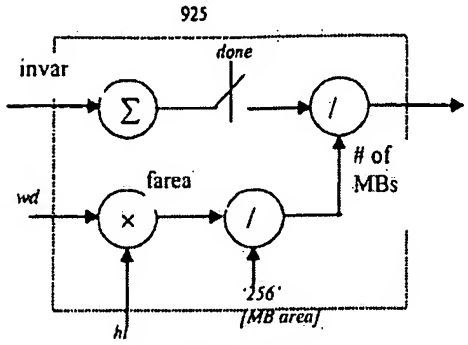

FIG. 10B

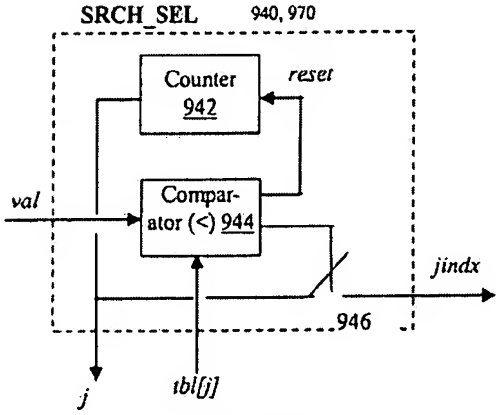

FIG. 10C

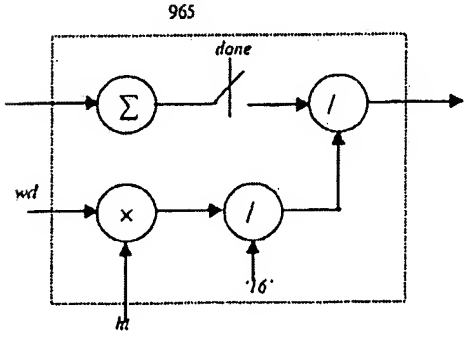

FIG. 10D

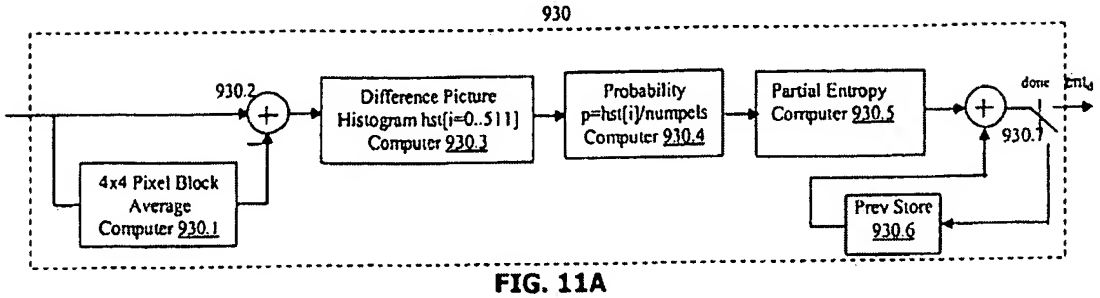

FIG. 11A

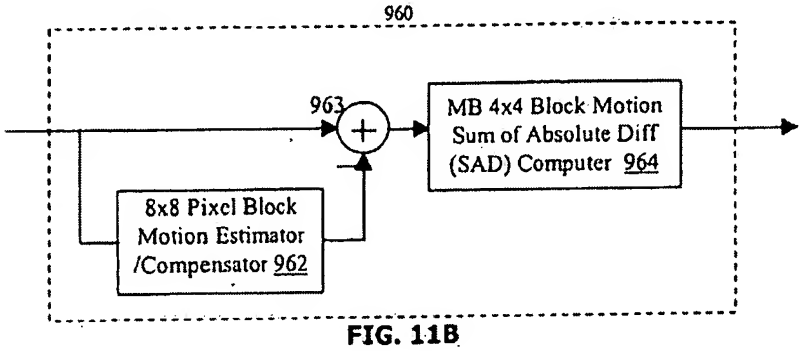

FIG. 11B

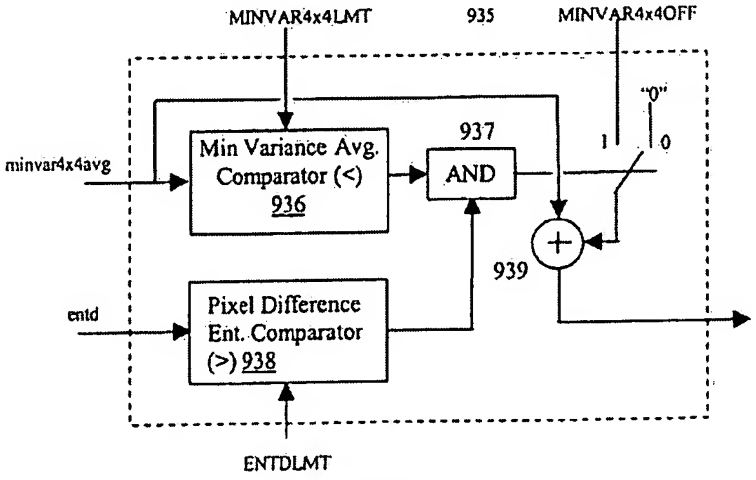

FIG. 11C

BBPID

0	1	2	3	4	5	6	7	8
0.01052	0.02104	0.04208	0.08416	0.16832	0.33664	0.67328	1.34656	2.69312

FIG. 12A - 915

CPID

0	1	2	3	4	5	6	7	8	9	10	11
1.0	2.0	4.5	8.5	12.5	17.0	22.0	28.0	34.0	41.0	50.0	60.0

12	13	14	15	16	17
71.0	84.0	100.0	120.0	145.0	177.0

FIG. 12B - 945

CPXID

0	1	2	3	4	5	6	7	8
1	3	5	7	9	11	13	15	17

FIG. 12C -955

CPMID

0	1	2	3	4
32.0	64.0	112.0	184.0	280.0

FIG. 12D - 975

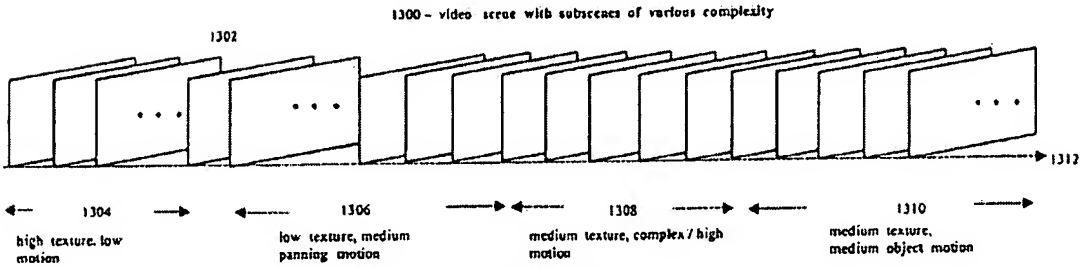

FIG. 13

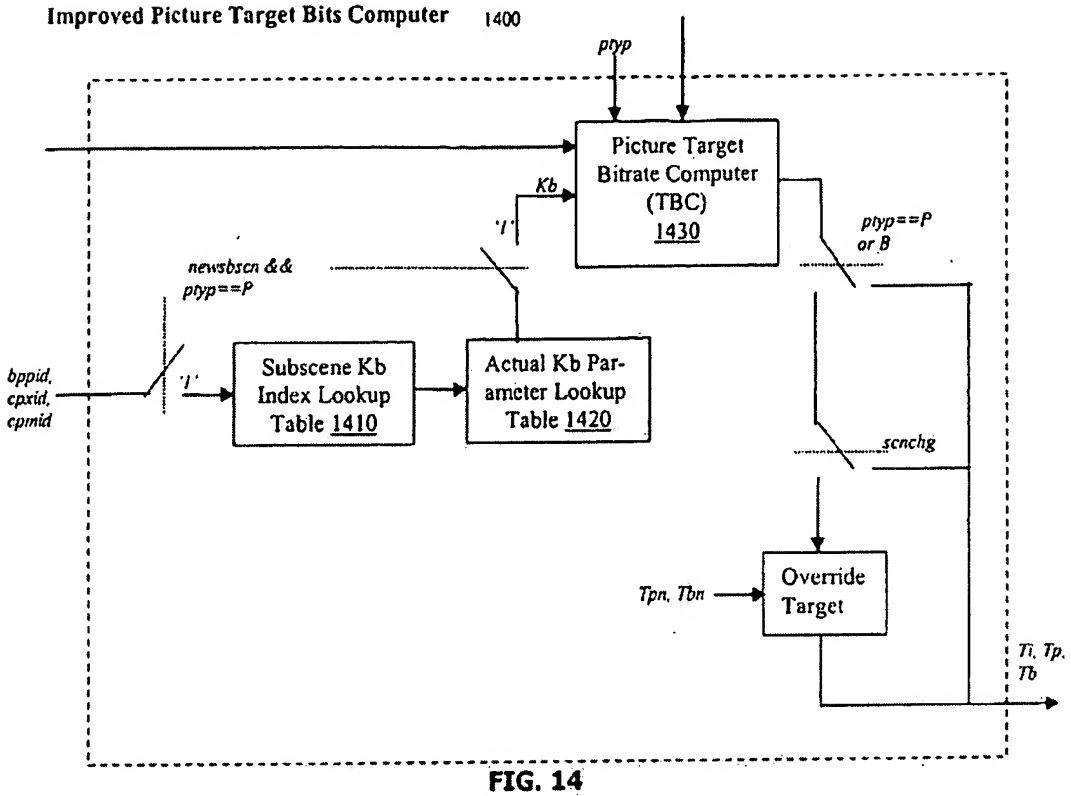

FIG. 14

KBID	0	1	2	3	4	5	6
	1.0250	1.2125	1.4000	1.5875	1.7500	1.9375	2.1250

FIG. 15A

CPMID=2

BPPID \ CPXID	0	1	2	3	4	5	6	7	8
0	2	2	2	3	3	3	4	4	4
1	2	2	2	2	3	3	3	4	4
2	2	2	2	2	2	3	3	3	4
3	2	2	2	2	2	2	3	3	3
4	2	2	2	2	2	2	2	3	3
5	2	2	2	2	2	2	2	2	3
6	1	2	2	2	2	2	2	2	2
7	1	1	2	2	2	2	2	2	2
8	1	1	1	2	2	2	2	2	2

CPMID=1

BPPID \ CPXID	0	1	2	3	4	5	6	7	8
0	2	2	2	2	2	3	3	3	3
1	2	2	2	2	2	2	3	3	3
2	2	2	2	2	2	2	2	3	3
3	2	2	2	2	2	2	2	2	3
4	2	2	2	2	2	2	2	2	2
5	1	2	2	2	2	2	2	2	2
6	1	1	2	2	2	2	2	2	2
7	1	1	1	2	2	2	2	2	2
8	1	1	1	1	2	2	2	2	2

FIG. 15B

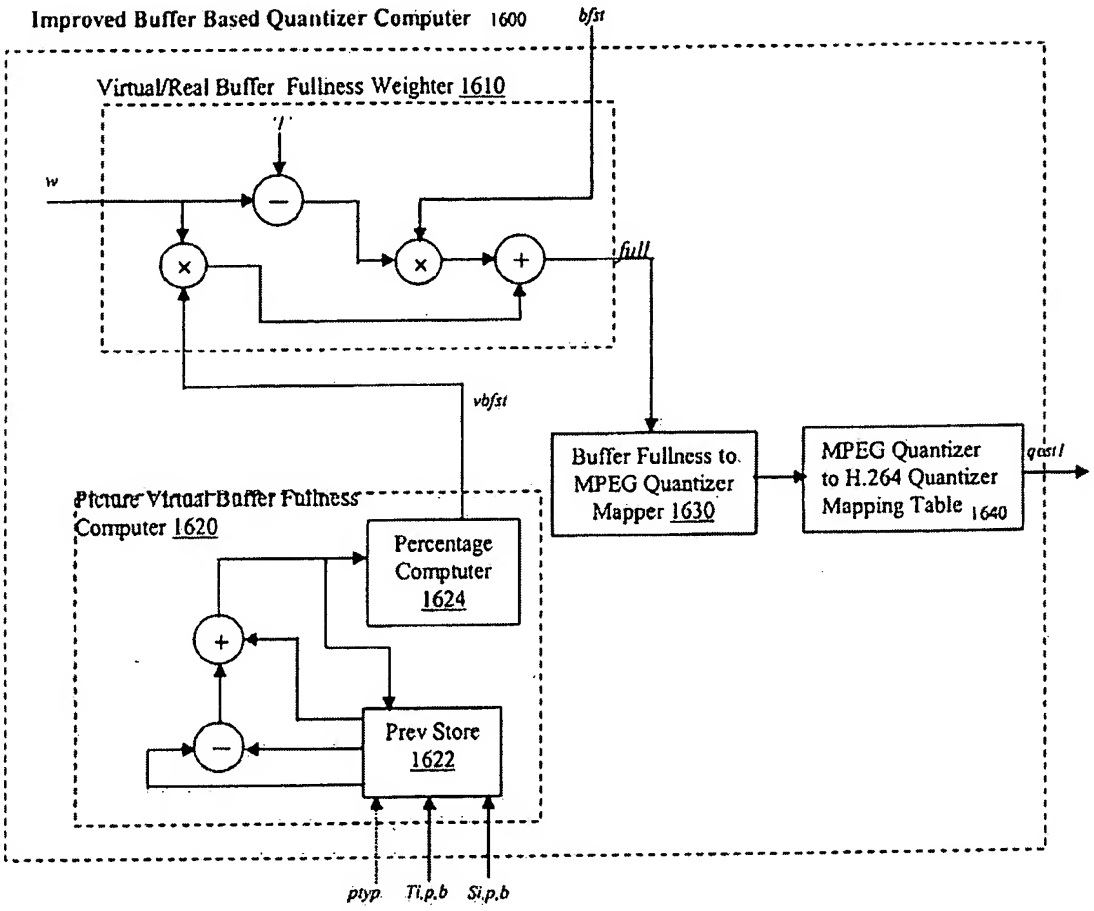
Improved Buffer Based Quantizer Computer 1600
bfst
Virtual/Real Buffer Fullness Weighter 1610
w
full
vbfst
Buffer Fullness to MPEG Quantizer Mapper 1630
MPEG Quantizer to H.264 Quantizer Mapping Table 1640
qpst1
Picture Virtual Buffer Fullness Computer 1620
Percentage Comptuter 1624
Prev Store 1622
ptyp
Ti,p,b
Si,p,b

FIG. 16

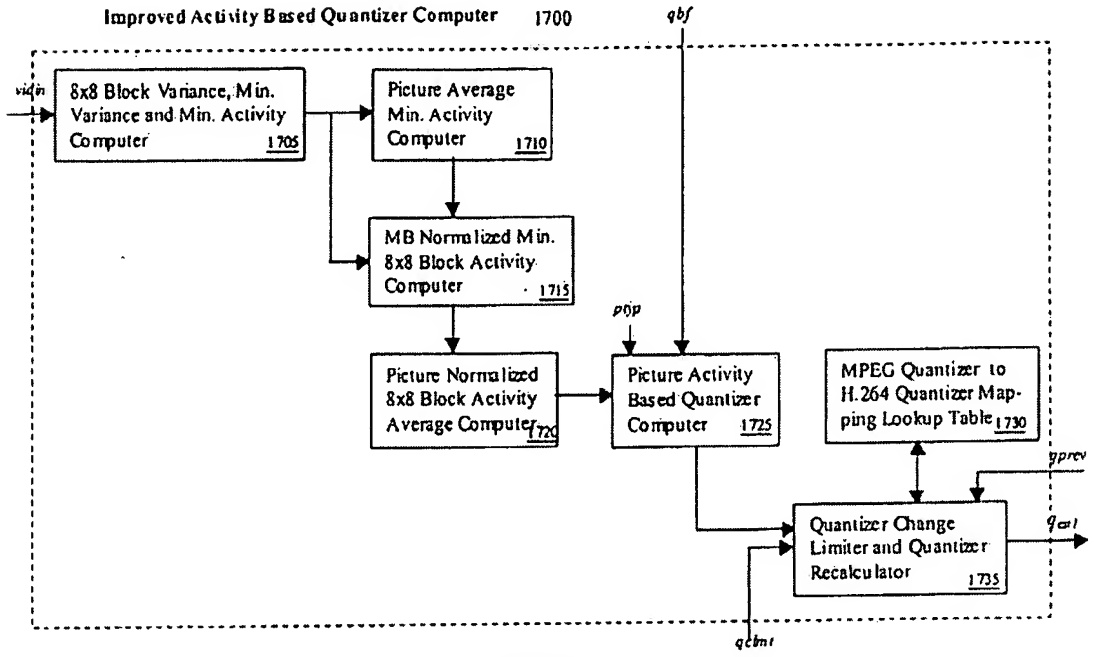

FIG. 17

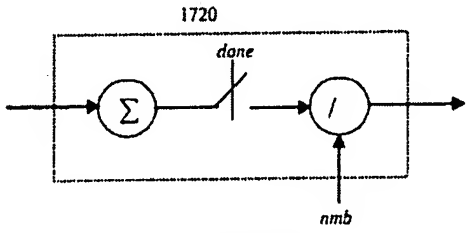

FIG. 18A

qh264

0	1	2	3	4	5	6	7	8	9	10	11	12
.250	.281	.315	.353	.396	.446	.500	.561	.623	.707	.794	.891	1.00

13	14	15	16	17	18	19	20	21	22	23	24	25
1.12	1.26	1.41	1.59	1.78	2.00	2.25	2.52	2.82	3.18	3.56	4.00	4.49

26	27	28	29	30	31	32	33	34	35	36	37	38
5.04	5.65	6.35	7.13	8.00	8.98	10.08	11.31	12.70	14.25	16.00	17.96	20.16

39	40	41	42	43	44	45	46	47	48	49	50	51
22.63	25.39	28.51	32.00	35.92	40.31	45.25	50.80	57.02	64.00	71.83	80.64	90.51

FIG. 18B

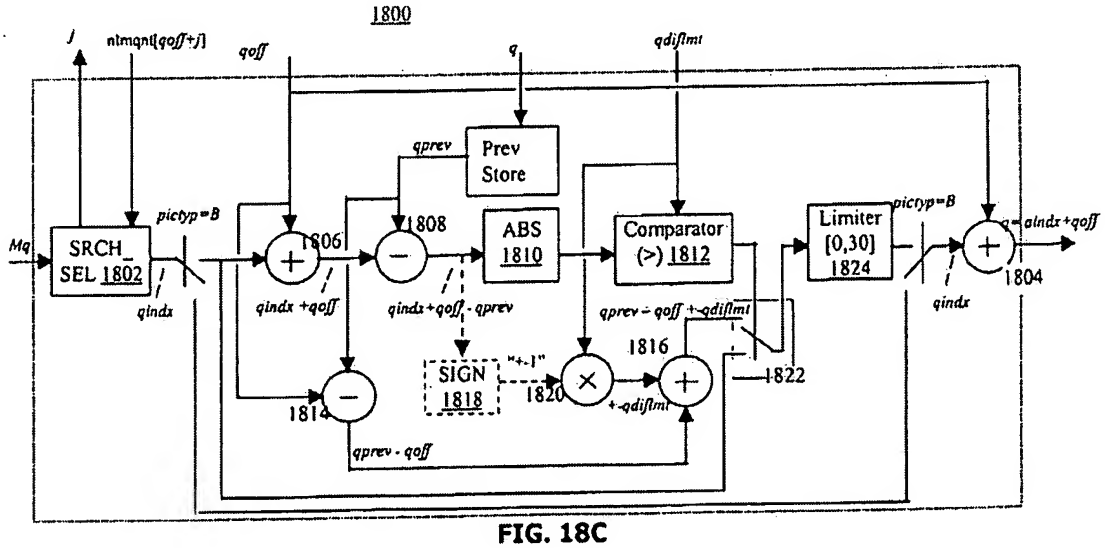

FIG. 18C

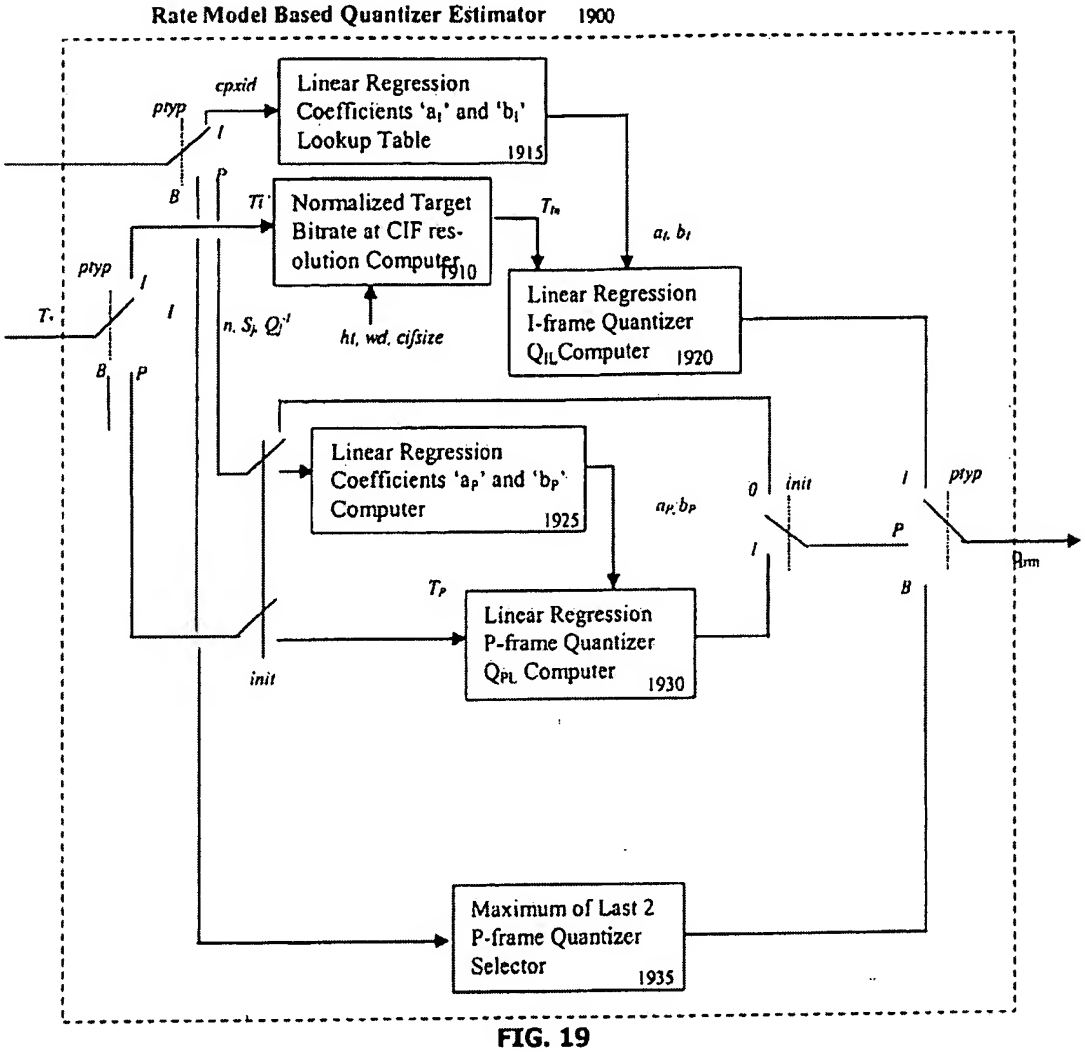

FIG. 19

CPID

0	1	2	3	4	5
-68134.59213	-87003.98467	-106202.60465	-125401.23463	-133506.23620	-141558.73699
6	**7**	**8**	**9**	**10**	**11**
-149611.24778	-151588.19751	-220858.39744	-293963.81117	-254808.46319	-215653.11522
12	**13**	**14**	**15**	**16**	**17**
-207487.50918	-1993321.90315	-191155.48428	-182989.06541	-178235.75132	-169521.36854

FIG. 20A

CPID

0	1	2	3	4	5
3313453.21342	3993567.19336	4565785.16255	5138003.13174	5715464.15501	6104194.66665
6	**7**	**8**	**9**	**10**	**11**
6492925.17829	6678722.15535	9084900.80067	11517856.77655	10611605.70466	9705354.63278
12	**13**	**14**	**15**	**16**	**17**
9777071.15962	9848787.68646	9920504.21330	9992220.74014	10623397.89991	11435042.39299

FIG. 20B

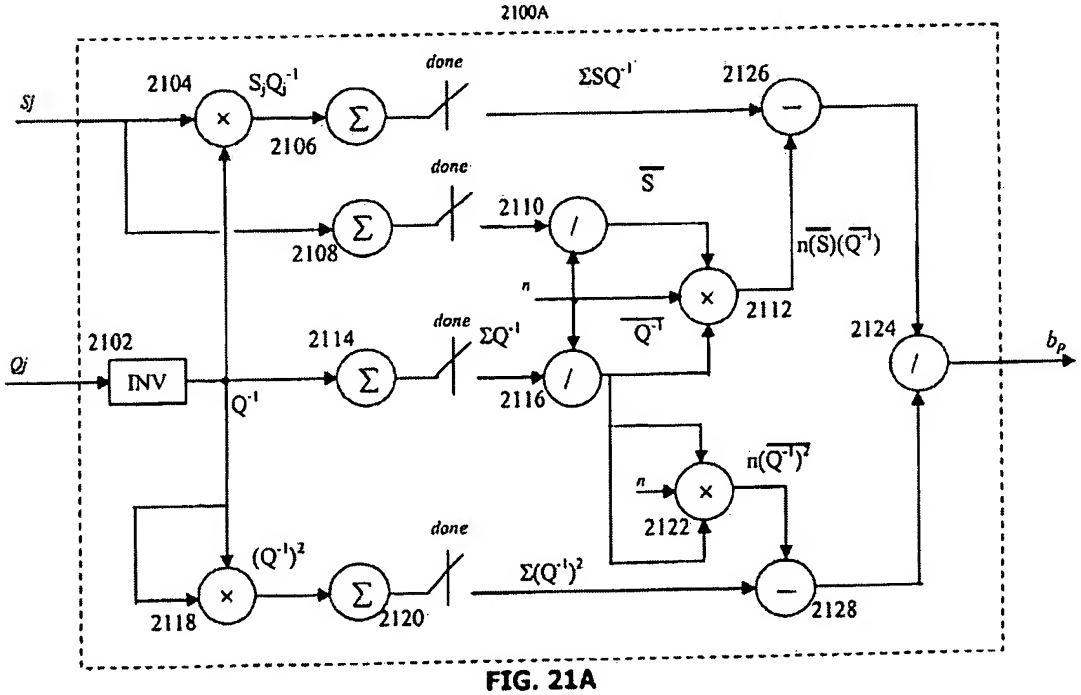

FIG. 21A

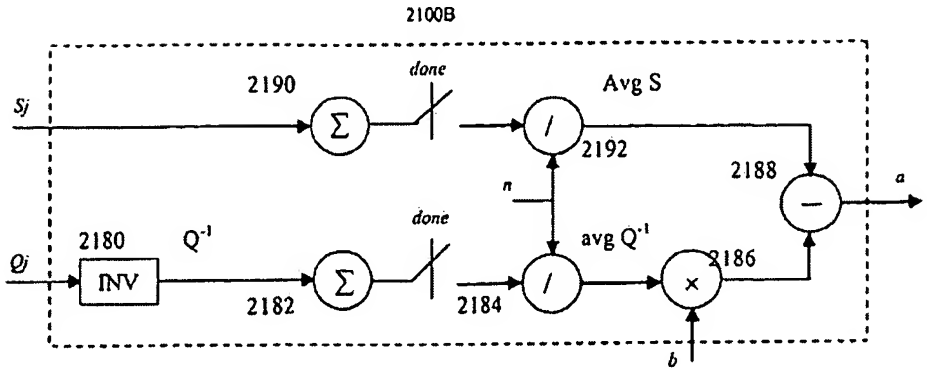

FIG. 21B

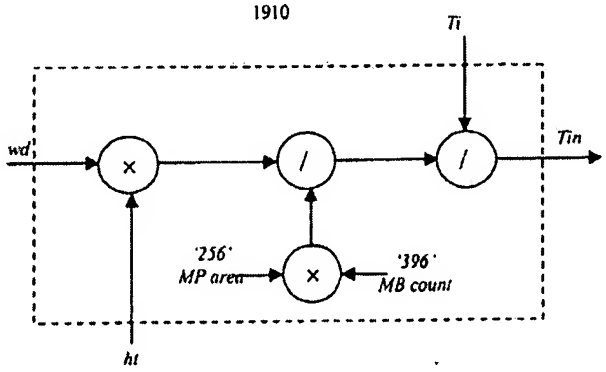

FIG. 22A

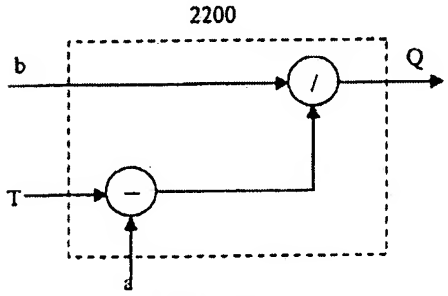

FIG. 22B

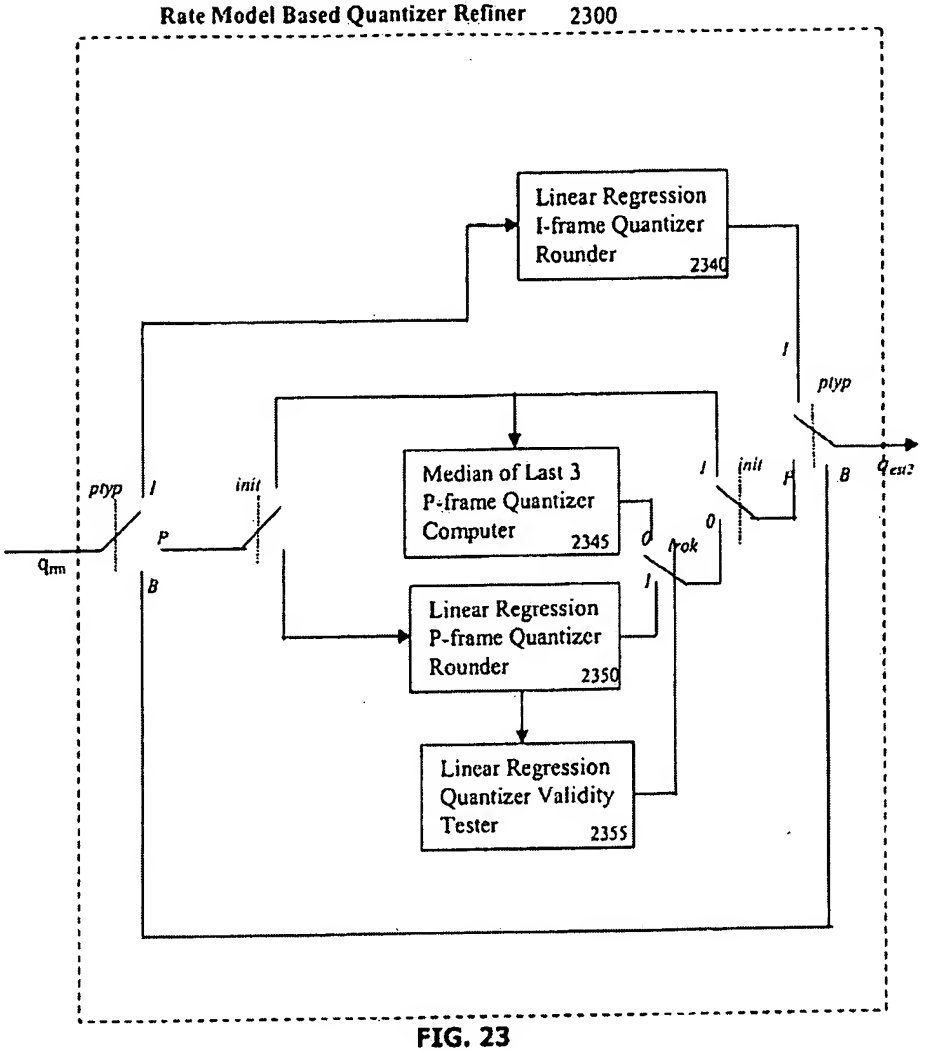

FIG. 23

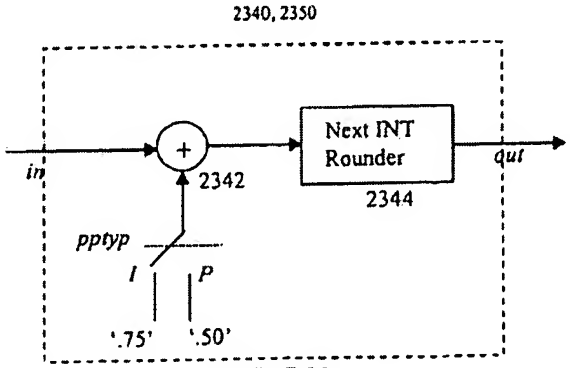

FIG. 24A

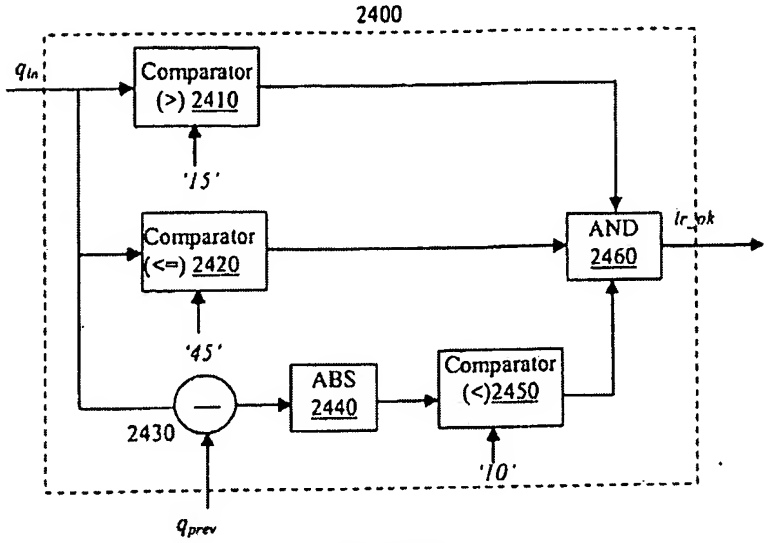

FIG. 24B

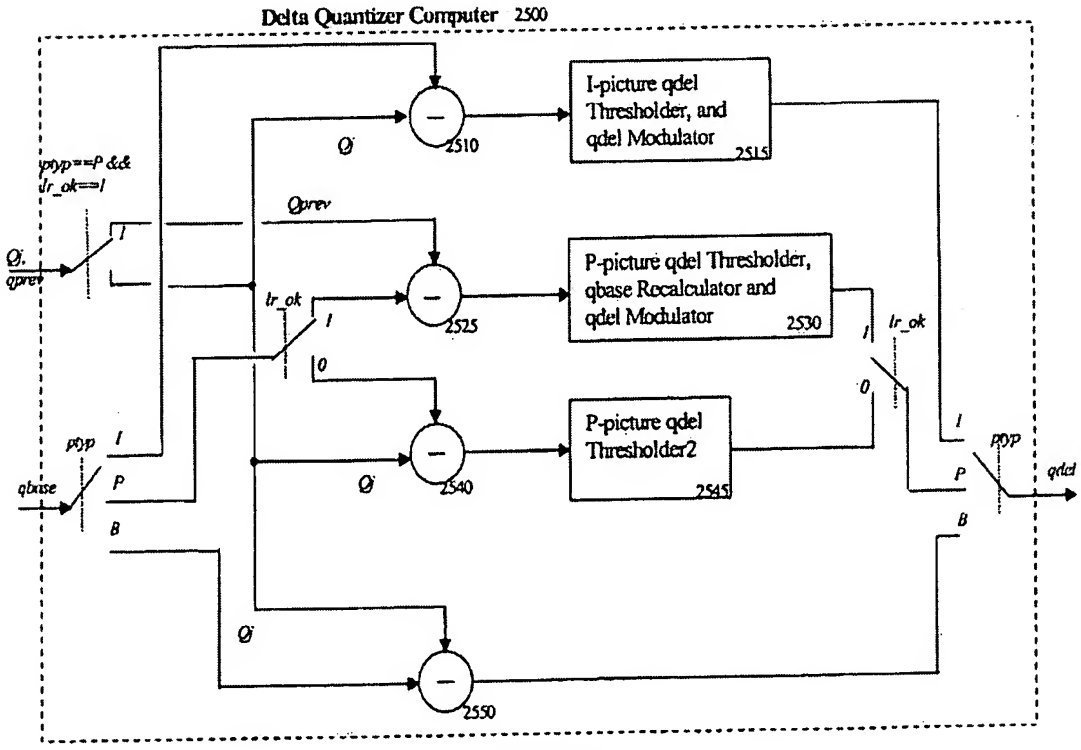

FIG. 25

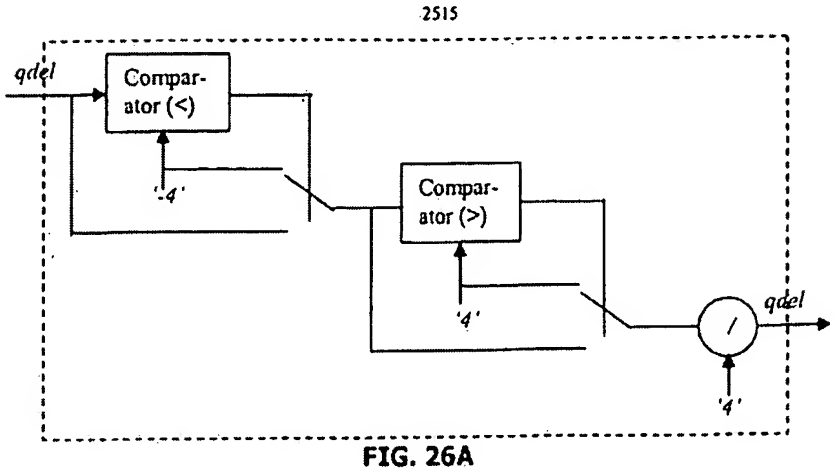

FIG. 26A

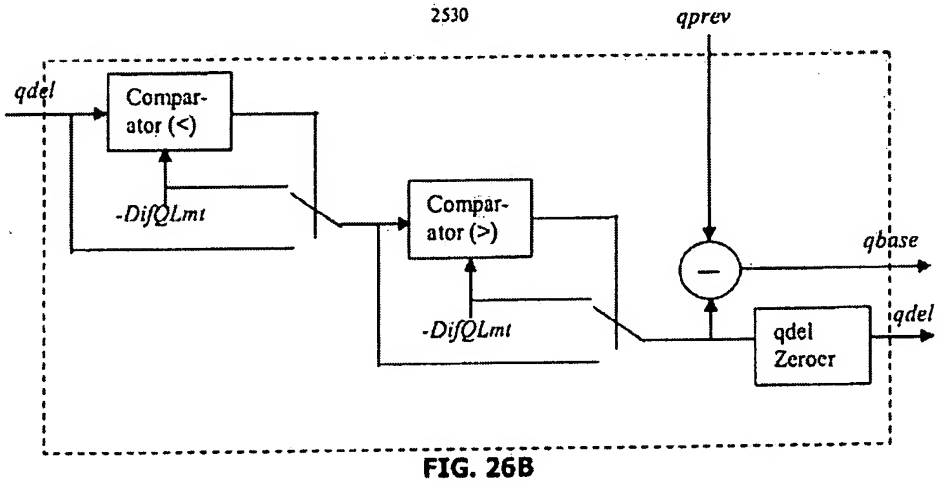

FIG. 26B

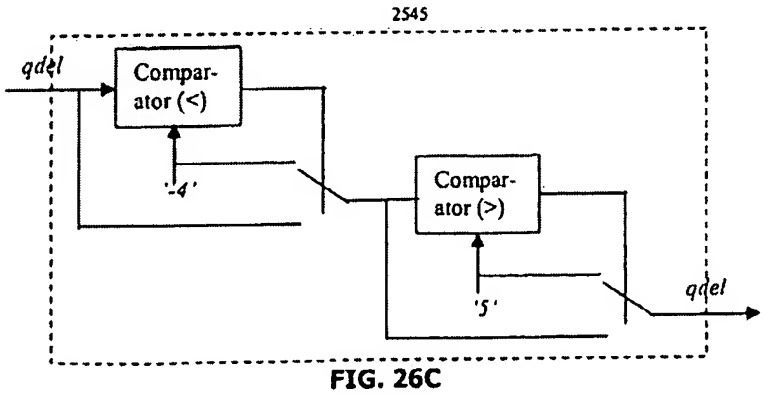

FIG. 26C

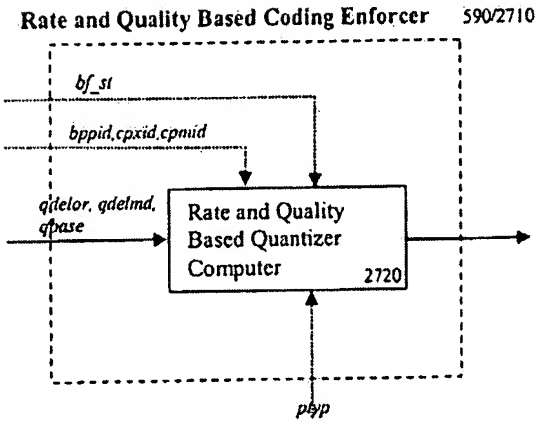
Rate and Quality Based Coding Enforcer
590/2710
bf_st
bppid,cpxid,cpnid
qdelor, qdelmd, qphase
Rate and Quality Based Quantizer Computer
2720
pbyp

FIG. 27

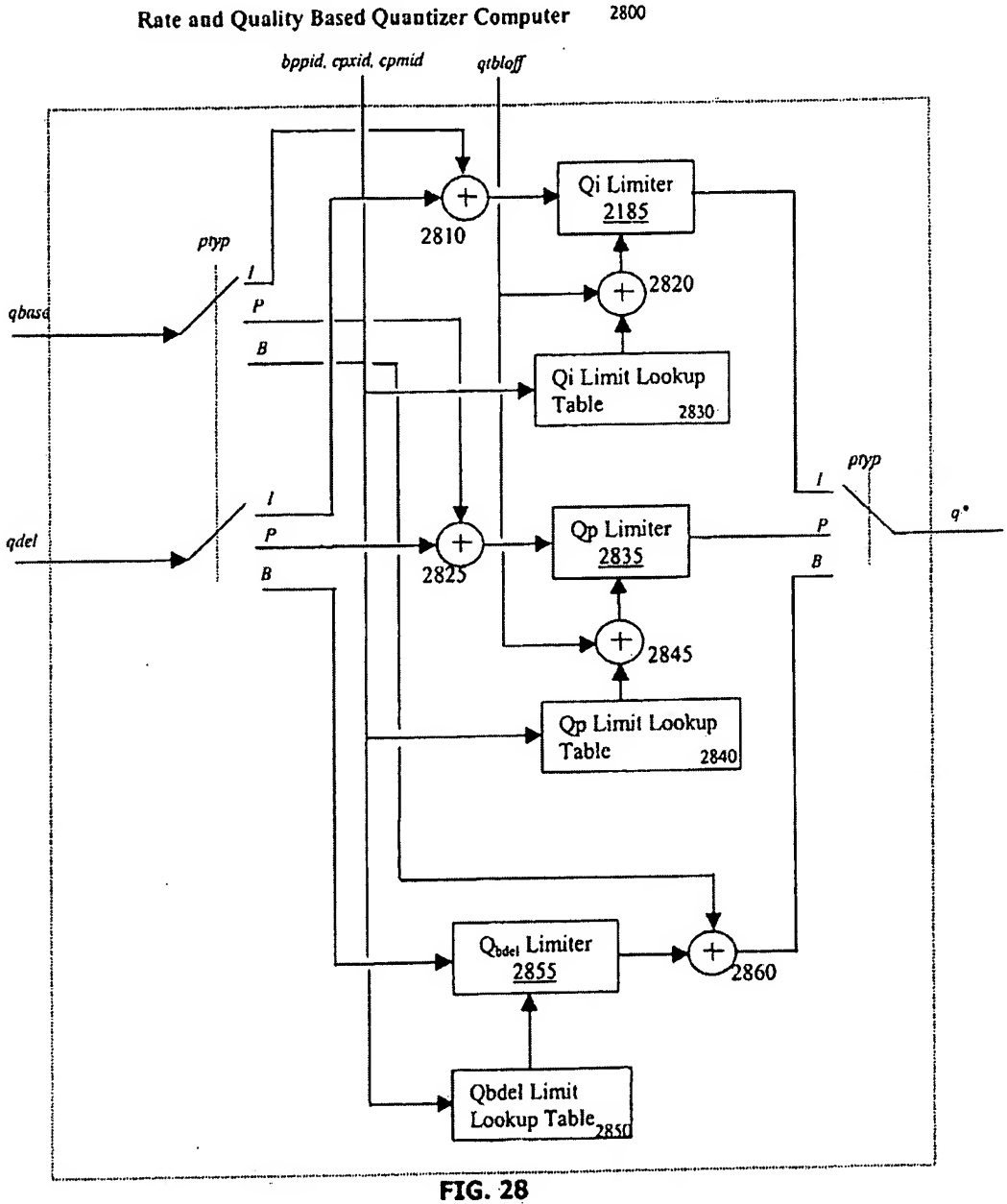
Rate and Quality Based Quantizer Computer 2800
bppid, cpxid, cpmid
qtbloff
ptyp
qbase
qdel
I
P
B
2810
Qi Limiter
2185
2820
Qi Limit Lookup
Table 2830
2825
Qp Limiter
2835
2845
Qp Limit Lookup
Table 2840
Qbdel Limiter
2855
2860
Qbdel Limit
Lookup Table 2850
q*

FIG. 28

BPPID \ CPXID	0	1	2	3	4	5	6	7	8
0	10	11	12	13	14	15	16	17	18
1	9	10	11	12	13	14	15	16	17
2	8	9	10	11	12	13	14	15	16
3	7	8	9	10	11	12	13	14	15
4	6	7	8	9	10	11	12	13	14
5	5	6	7	8	9	10	11	12	13
6	4	5	6	7	8	9	10	11	12
7	3	4	5	6	7	8	9	10	11
8	2	3	4	5	6	7	8	9	10

FIG. 29A

BPPID \ CPXID	0	1	2	3	4	5	6	7	8
0	10	11	12	13	14	15	16	17	18
1	9	10	11	12	13	14	15	16	17
2	8	9	10	11	12	13	14	15	16
3	7	8	9	10	11	12	13	14	15
4	6	7	8	9	10	11	12	13	14
5	5	6	7	8	9	10	11	12	13
6	4	5	6	7	8	9	10	11	12
7	3	4	5	6	7	8	9	10	11
8	2	3	4	5	6	7	8	9	10

FIG. 29B

BPPID \ CPXID	0	1	2	3	4	5	6	7	8
0	2	2	2	3	3	3	4	4	4
1	1	2	2	2	3	3	3	4	4
2	1	1	2	2	2	3	3	3	4
3	1	1	1	2	2	2	3	3	3
4	1	1	1	1	2	2	2	3	3
5	0	1	1	1	2	2	2	2	3
6	0	0	1	1	1	2	2	2	2
7	0	0	0	1	1	1	2	2	2
8	0	0	0	0	1	1	1	2	2

FIG. 29C

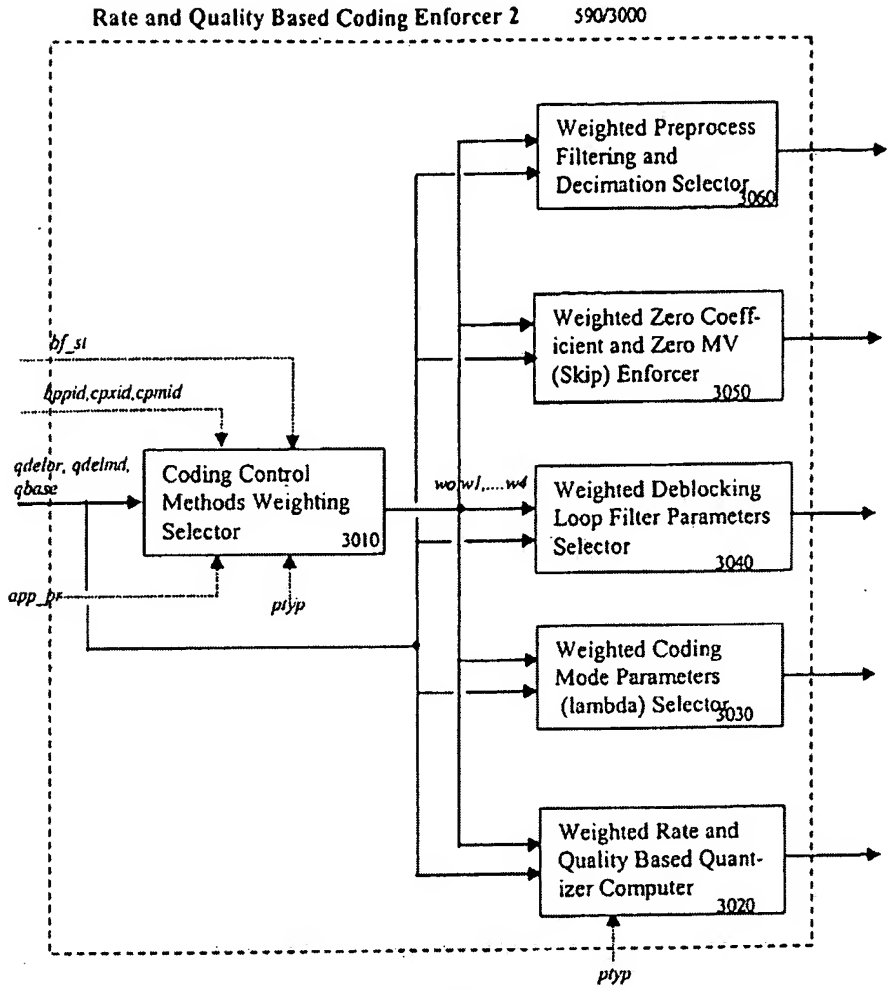
Rate and Quality Based Coding Enforcer 2
590/3000
Weighted Preprocess Filtering and Decimation Selector
3060
Weighted Zero Coeff-icient and Zero MV (Skip) Enforcer
3050
Weighted Deblocking Loop Filter Parameters Selector
3040
Weighted Coding Mode Parameters (lambda) Selector
3030
Weighted Rate and Quality Based Quant-izer Computer
3020
bf_sl
lppid,cpxid,cpmid
qdelpr, qdelmd, qbase
Coding Control Methods Weighting Selector
3010
wo,w1,....w4
app_pr
ptyp
ptyp

FIG. 30

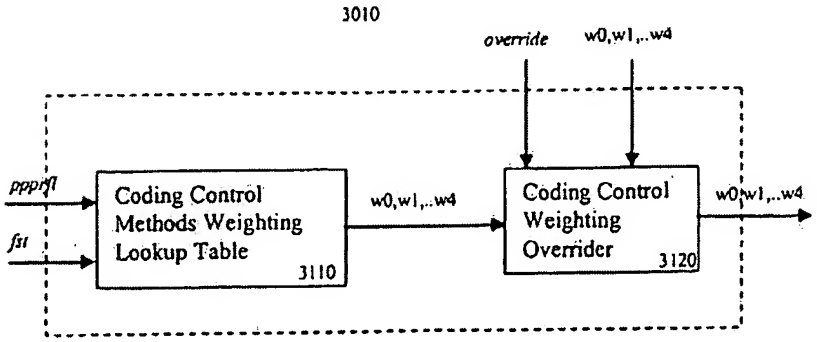
3010
override
w0,w1,..w4
pppnfl
fsl
Coding Control Methods Weighting Lookup Table
3110
w0,w1,..w4
Coding Control Weighting Overrider
3120
w0,w1,..w4

FIG. 31

app_pr \ bfst	0	1	2	3	4	5	6
0	0.23	0.30	0.18	0.26	0.07	0.07	0.26
1	0.11	0.48	0.25	0.03	0.23	0.15	0.19
2	0.08	0.21	0.45	0.18	0.15	0.12	0.15
3	0.44	0.39	0.07	0.09	0.31	0.45	0.28
4	0.47	0.30	0.28	0.12	0.08	0.35	0.10
5	0.44	0.37	0.10	0.30	0.29	0.15	0.41
6	0.20	0.47	0.38	0.22	0.44	0.27	0.27
7	0.10	0.12	0.47	0.27	0.10	0.09	0.22
8	0.30	0.22	0.49	0.46	0.18	0.49	0.47
9	0.11	0.44	0.07	0.03	0.36	0.09	0.35

0	1	2	3	4	5	6				
0.09	0.09	0.05	0.27	0.21	0.27	0.31	0.25	0.09	0.33	
0.22	0.45	0.16	0.20	0.24	0.45	0.18	0.09	0.38		
0.09	0.12	0.46	0.26	0.21	0.15	0.07	0.36			
0.37	0.05	0.16	0.01	0.28	0.06	0.19				

FIG. 32

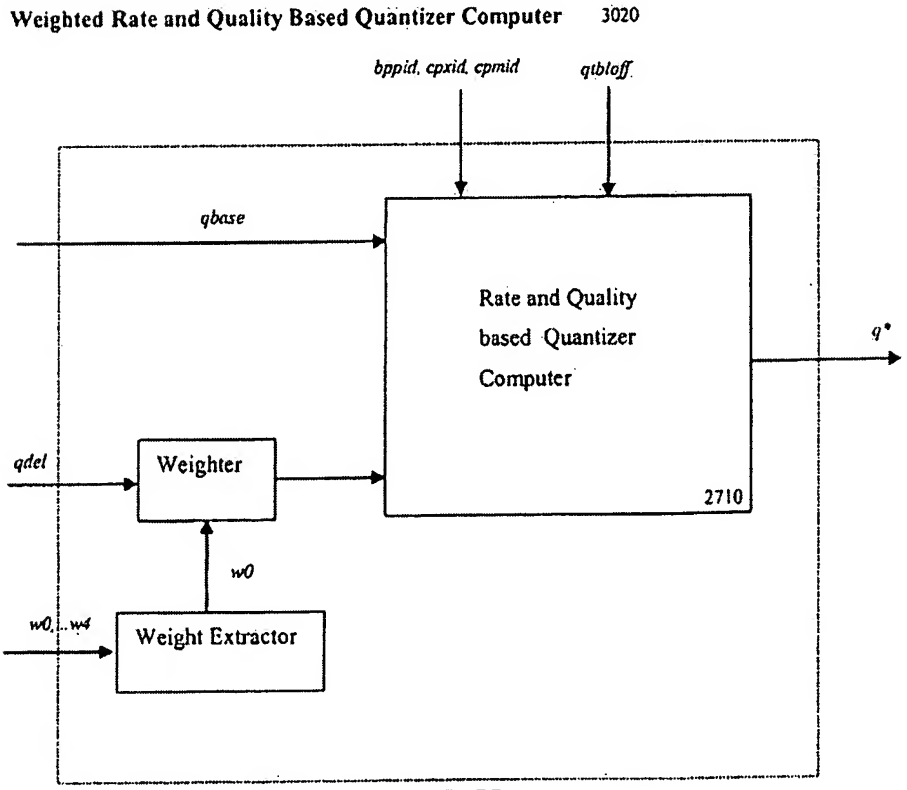

FIG. 33